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CARTOGRAPHIC EVALUATION OF ERTS ORBIT AND ATTITUDE DATA

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Type I Progress Report

ERTS I

- a. Title: Cartographic Evaluation of ERTS Orbit and Attitude Data

ERTS A Proposal: SR 150

- b. GSFC ID No. of P.I.: IN 043

- c. Problems:

1. As indicated in previous progress reports, the lack of RBV images will require a revised set of objectives for this investigation. Recommendations are included in section f.

- d. Accomplishments:

1. Approximately 15 MSS images have been evaluated for geometric distortion using measurements of ground control points. The best results have been with scene 1080-15192-5 which had an 192 m rms residual distortion after a least square linear transformation, figure 1. Based on other investigations, it appears possible to improve the geometric accuracy further through an improved calibration of the mirror velocity profile.

2. A photogrammetric resection of one RBV frame gave an orbit position within ± 425 m in x-y and ± 125 m in z. The roll and pitch were within ± 1.5 arc minutes and the yaw was ± 0.5 arc second. This work was accomplished in cooperation with Dr. Kam Wong who has a USGS contract on RBV image quality. These results confirm the concept that the excellent geometric quality of the RBV can be used to evaluate spacecraft orbit and attitude data.

Note: Image coordinates fit to UTM coordinates using four parameters: X and Y translation, rotation, and scale. Error (rms) for this band is 192 m; average for the 4 bands of this scene is 210 m.

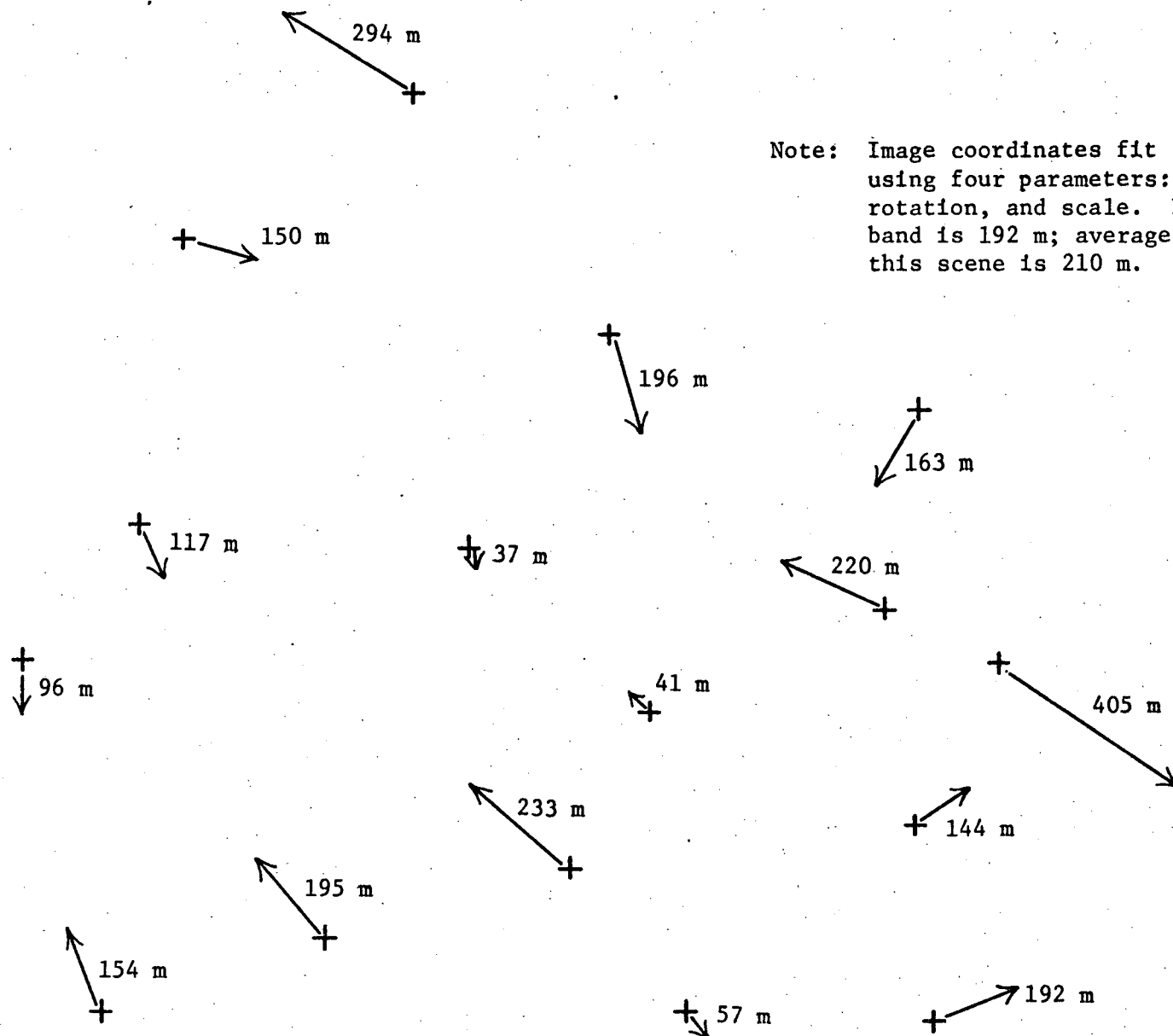


Figure 1.--MSS bulk-image distortion (meters);
frame 1080-15192-5, Chesapeake Bay area.

3. A computer program is being written to compute the exact UTM center location of a MSS scene and compare this against annotation data and the BIAT output.

e. Published articles and reports:

None

f. Recommended changes in operations:

The following changes should be made a formal part of the investigation contract:

1. Both MSS and/or RBV images will be used.
2. The MSS images will be used to evaluate sensor distortion and MSS geometric and cartographic calibration data.
3. A UTM ground coordinate system may be used in place of geocentric or local coordinates if the image distortions are the dominant error (>100 m).
4. The goal of the investigation is to quantify the relationship and accuracy of image geometry, annotation position data, and orbit position and attitude data. However if only MSS images are available, the primary emphasis will be on image geometry.
5. Based on the revised goals a revised standing order for imagery (either MSS or RBV) is requested as given in item g, h, and i, No standing orders have been previously requested under this experiment since it was planned to order RBV images retrospectively. All evaluations to date have been performed on images from the NDPF quality control section or from other investigators.

The eight sites selected are in areas of good ground control. Four sites are on the north and south portions of two U.S. orbital tracks. Other sites are distributed in latitude and longitude to allow correlation against attitude rates.

- g. Changes in Standing Order Forms: See attached form
- h. ERTS Image Descriptor Forms: N/A
- i. Changes in Data Request Forms: See attached form
- j. DCP Status: N/A

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ERTS B
PRODUCT REQUEST FORMDATE 1 March 1973Principal Investigator Robert B. McEwenIdentification Number IN 043Telephone Number (202) 343-9461
(area code) (number)

Section 1.0 GENERAL INFORMATION

Separate Product Request Forms must be completely filled out for each separate "test site" location as defined in Section 2.

1.1 TEST SITE NUMBER

- a. Indicate the total number of test sites requested by you 8.
- b. Number your test sites 1, 2, 3. . .
- This product request form is for test site number 1.

1.2 SHIP-TO ADDRESS

All ERTS-B data products for any one test site will be shipped to one investigator, who will distribute the products to concerned personnel.

The ship-to address is:

<u>Robert B. McEwen</u>		
	(name)	
<u>U.S.G.S.</u>		
	(agency)	
<u>1340 Old Chain Bridge Road</u>		
	(street)	
<u>McLean,</u>	<u>Va.</u>	<u>22101</u>
(city)	(state)	(zip)

Section 2.0 TEST SITE (GEOGRAPHICAL AREA) REQUIREMENTS

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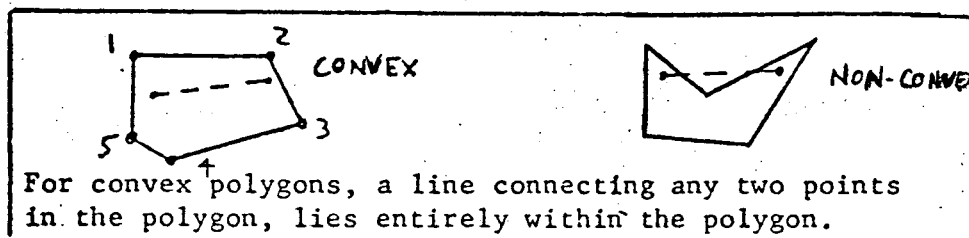
Indicate the geographical area of interest. Each product request can be based on one and only one area. If more than one area is required, a separate request form must be filled out.

2.1 GENERAL TEST SITE LOCATION

- If in the United States, indicate the state(s) New Hampshire.
- If outside the United States, indicate the country(ies) -.

2.2 TEST SITE COORDINATES

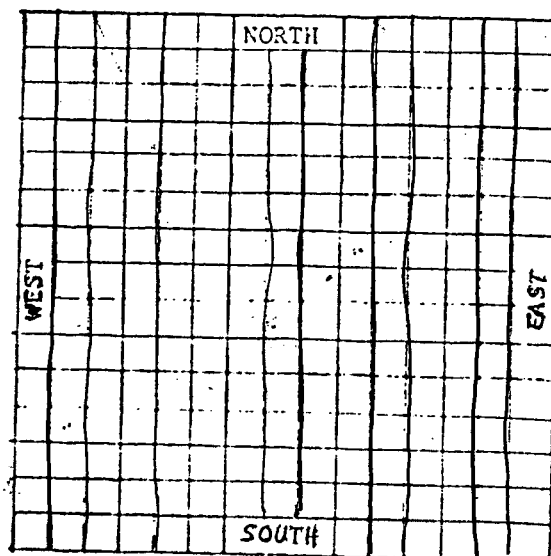
- If the test site is an area of less than 50 nautical miles radius, only a "single point" entry is required. On line 1 of the table below enter the latitude and longitude of the center point of the single point entry.
- For larger areas, use the accompanying grid to sketch the geographical boundaries (the grid is not to scale). Only convex polygons with three to six corner points are permitted as defined below:



No side of the polygon can be less than 10 nautical miles long.

- Number the corner points in clockwise order starting with the leftmost point. For polygons with two leftmost points (ie, both have the same longitude) start with the upper leftmost point. Enter the geographic coordinates of each point in the table below.

POINT NO.	latitude					longitude				
	DEC		MIN	DIR		DEC		MIN	DIR	
1	4	3	0	0		0	7	1	0	0
2										
3										
4										
5										
6										



Section 3.0 CLOUD COVER AND TIME PERIOD REQUIREMENTS

DATA QUALIFICATIONS: A product request must be qualified on the basis of maximum acceptable cloud cover. Furthermore, one or more time periods for which data is required must be specified. Complete the following sections in accordance with your requirements.

- 3.1 Indicate the maximum cloud cover acceptable to you by checking the appropriate block in the table below. Example: If you check "30," you will not receive images that contain more than 30% cloud cover. If you check "100," no images specified in Section 4.0 will be rejected because of cloud cover. The investigator should determine his maximum cloud cover carefully. For most investigations, a request for 100 percent cloud-covered imagery is unrealistic. On the other hand, cloud cover of 10 percent or less is seldom obtainable. Because of the load on the NDPF system, unrealistic cloud cover requirements are subject to revision by NASA.

10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
X									

- 3.2 Check the time period(s) for which you require data for the area specified in Section 2.0. This time period shall apply to all products specified in Section 4.0. Note that data will be supplied for only those time periods specified. The NDPF will be severely taxed. Please determine time periods for which you require coverage with care. Requests for frequently repeated coverage will be examined carefully and will be reduced unless justified.

Month	1972		1973											
	1973		1974											
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
					X	X	X	X	X	X	X			

Section 4.0 REQUESTS FOR BULK BLACK AND WHITE FILM PRODUCTS

The NDPF supplies Bulk black and white film products to investigators who have established a "standing order." A standing order is an order for products prior to the time the spacecraft actually acquires the data. The information supplied in sections 2, 3 and 4 of this Product Request Form will become the standing orders of accepted proposals. Note that the test sites specified via standing orders determine the geographical areas over which the spacecraft will gather data.

Only Bulk black and white film products can be ordered via standing orders, but it must be noted that the Precision products are not necessarily "better" than the Bulk products. The Precision products do provide greater geometric fidelity, i.e., they can be used for more precisely locating topographical features; but this can only be obtained by trading off resolution and radiometric accuracy. Bulk products contain all the radiometric and initial

spatial corrections introduced during the conversion of video tape to film and will be the most useful instrument for most investigations. 4/5

Each of the available formats is best suited to specific applications. The 70mm negative transparencies constitute the most basic tool for those capable of utilizing it. From the negatives, all other formats can be most readily produced. The positive transparencies, either 70mm or 9½ inch, can be used to form color composite images. The 70mm format is required for virtually all color additive machines. The scale of the positive print is 1=1,000,000, which reduces its value even in most field studies. Prints of suitable working scale can be most easily produced from the negatives.

a. For each product desired, write the number of copies desired in the boxes in the table below. Where no copies are desired, write "0". The products will be provided for the test site specified in Section 2 and for the coverage period as specified in Section 3. (The NDPF Processing Code is for internal use only.)

b. Circle the spectral bands desired. The relationship between the sensor, spectral band and wavelength is explained in Appendix B.

NDPF Processing Code		Indicate the number of copies	Circle the Spectral Bands Desired	
			RBV 1 2 3	MSS 4 5 6 7
M	Bulk Black & White 70mm Negative Transparency	<input type="checkbox"/>		
S	Bulk Black & White 70mm Positive Transparency	<input type="text" value="2"/>	<u>1 2 3</u>	<u>4 5 6 7</u>
T	Bulk Black & White 9½ inch Positive Transparency	<input type="text" value="2"/>	<u>1 2 3</u>	<u>4 5 6 7</u>
P	Bulk Black & White 9½ inch Positive Paper Print	<input type="text" value="2"/>	<u>1 2 3</u>	<u>4 5 6 7</u>

Section 5.0 ANTICIPATED REQUIREMENTS FOR PRECISION, COLOR AND DIGITAL PRODUCTS

Precision, color and digital products can only be ordered retrospectively, i.e., after viewing the corresponding bulk black and white products received via standing orders. Each investigator should review his standing order carefully, to determine whether the information content of any given ERTS image merits requesting additional imagery. In order to avoid oversubscribing the NDPF, the following products can be obtained only if necessary to the experiment. Indicate those products which you anticipate requesting retrospectively in the following four sections. As with the standing order products, each format is best suited to specific applications, as discussed below. Before ordering any of these products, it is suggested that investigators review Section 4.0 above and Appendix F of the ERTS Data Users Handbook.

PRECISION BLACK & WHITE PRODUCTS

Most investigators will find little or no value in Precision paper prints. In

general, the comments on the product formats given in Section 4.0 above also apply to Precision products.

a. For each product desired, write the number of copies desired in the boxes in the table below. Where no copies are desired, write "0." The products will be provided for the test site specified in Section 2 and for the coverage period as specified in Section 3.

b. Circle the spectral bands desired. The relationship between the sensor, spectral band and wavelength is explained in Appendix B.

NDPF Processing Code		Indicate the Number of Copies	Circle the Spectral Bands Desired
		RBV 1 2 3	MSS 4 5 6 7
<input type="checkbox"/> AN	Precision Black & White 9½ inch Negative Transparency	<input type="checkbox"/>	
<input type="checkbox"/> AT	Precision Black & White 9½ inch Positive Transparency	<input type="checkbox"/> 2	<u>1 2 3</u> <u>4 5 6</u>
<input type="checkbox"/> AP	Precision Black & White 9½ inch Positive Paper Print	<input type="checkbox"/> 2	<u>1 2 3</u> <u>4 5 6 7</u>

5.2 COLOR COMPOSITE BULK PROCESSED PRODUCTS

Color composite products are provided primarily for comparison purposes. Superior color products will be obtained by combining the individual black and white transparencies. The NDPF cannot provide the personalized treatment required for each experiment. Therefore requests for color imagery must be justified.

NOTE: For color imagery, standard products are available in the following band/filter combinations:

Type "A" --RBV band 1 (Cyan), band 2 (Magenta), band 3 (Yellow)

Type "B" --MSS band 4 (Cyan), band 5 (Magenta), band 6 (Yellow)

Type "C" --MSS band 4 (Cyan), band 5 (Magenta), band 7 (Yellow)

a. Write the number of products desired in the boxes below. Where no copies are desired, write "0."

b. Circle the type(s) desired.